Review

A SYSTEMATIC REVIEW OF AUTOPSY FINDINGS IN DEATHS AFTER COVID-19 VACCINATION

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Abstract

Background: The rapid development and widespread deployment of COVID-19 vaccines, combined with a high number of adverse event reports, have led to concerns over possible mechanisms of injury including systemic lipid nanoparticle (LNP) and mRNA distribution, spike protein-associated tissue damage, thrombogenicity, immune system dysfunction, and carcinogenicity. The aim of this systematic review is to investigate possible causal links between COVID-19 vaccine administration and death using autopsies and post-mortem analysis.

Methods: We searched for all published autopsy and necropsy reports relating to COVID-19 vaccination up until May 18th, 2023. We initially identified 678 studies and, after screening for our inclusion criteria, included 44 papers that contained 325 autopsy cases and one necropsy case. Three physicians independently reviewed all deaths and determined whether COVID-19 vaccination was the direct cause or contributed significantly to death.

Findings: The most implicated organ system in COVID-19 vaccine-associated death was the cardiovascular system (53%), followed by the hematological system (17%), the respiratory system (8%), and multiple organ systems (7%). Three or more organ systems were affected in 21 cases. The mean time from vaccination to

death was 14.3 days. Most deaths occurred within a week from last vaccine administration. A total of 240 deaths (73.9%) were independently adjudicated as directly due to or significantly contributed to by COVID-19 vaccination.

Interpretation: The consistency seen among cases in this review with known COVID-19 vaccine adverse events, their mechanisms, and related excess death, coupled with autopsy confirmation and physician-led death adjudication, suggests there is a high likelihood of a causal link between COVID-19 vaccines and death in most cases. Further urgent investigation is required for the purpose of clarifying our findings.

Keywords: Autopsy; necropsy; COVID-19; COVID-19 vaccines; mRNA; SARS-CoV-2 vaccination; death; excess mortality; spike protein; organ system

Research in context

Evidence before this study

COVID-19 vaccines, with known mechanisms of injury to the human body and a substantial number of adverse event reports, represent an exposure that we hypothesized to be possibly linked to death in some cases. Thus, we searched PubMed and ScienceDirect for all published autopsy and necropsy reports relating to COVID-19 vaccination through May 18th, 2023 using keywords relating to COVID-19 vaccines, death, autopsy, and necropsy. We found that no comprehensive review of autopsy findings in a large series of deaths after COVID-19 vaccination that accounts for the current state of knowledge has been conducted. The mechanisms of death from COVID-19 vaccination remain largely unexplored.

Added value of this study

Because the state of knowledge has advanced since the time of the original publications, new assessments regarding COVID-19 vaccine adverse events can be made. Based on the previously published literature of COVID-19 vaccine adverse events, their mechanisms, and related excess death, coupled with autopsy confirmation and physician-led death adjudication, we found a high likelihood of a causal link between COVID-19 vaccines and death among most of the 326

included cases. This is the first study that indicates a high probability of causality between COVID-19 vaccine administration and death in many cases. To date, this is the largest review of autopsy findings in deaths after COVID-19 vaccination, helping the medical community to better understand fatal COVID-19 vaccine syndromes.

Implications of all the available evidence

Further urgent investigation is required aimed at confirming our results and further elucidating the mechanisms underlying the described fatal outcomes with the goal of risk mitigation for the large numbers of individuals who have taken one or more COVID-19 vaccines. If a large number of deaths are indeed causally linked to COVID-19 vaccination, the implications could be immense, including: the complete withdrawal of all COVID-19 vaccines from the global market, suspension of all remaining COVID-19 vaccine mandates and passports, loss of public trust in government and medical institutions, investigations and inquiries into the censorship, silencing and persecution of doctors and scientists who raised these concerns, and compensation for those who were harmed as a result of the administration of COVID-19 vaccines.

Introduction

As of May 31st, 2023, SARS-CoV-2 has infected an estimated 767,364,883 people globally, resulting in 6,938,353 deaths[1]. As a direct response to this worldwide catastrophe, governments adopted a coordinated approach to limit caseloads and mortality utilizing a combination of non-pharmaceutical interventions (NPIs) and novel gene-based vaccine platforms. The first doses of vaccine were administered less than 11 months after the identification of the SARS-CoV-2 genetic sequence (in the United States, under the Operation Warp Speed initiative), which represented the fastest vaccine development in history with limited assurances of short and long-term safety[2]. At the time of writing, about 69% of the world population have been inoculated with at least one dose of a COVID-19 vaccine[1].

The most frequently utilized COVID-19 vaccine platforms include inactivated virus (Sinovac – CoronaVac), protein subunit (Novavax – NVX-CoV2373), viral vector (AstraZeneca – ChAdOx1 nCoV-19, Johnson & Johnson – Ad26.COV2.S), and messenger RNA (Pfizer-BioNTech – BNT162b2, Moderna – mRNA-1273)[3]. All utilize mechanisms that can cause serious adverse events; most involve the uncontrolled synthesis of the spike glycoprotein (SP) as the basis of the immunological response. Circulating SP is the likely deleterious mechanism

through which COVID-19 vaccines produce adverse effects[4,5,7,8,10,11]. SP and/or subunits/peptide fragments can trigger ACE2 receptor degradation and internalization, which may also cause destabilization of the renin–angiotensin system (RAS), resulting in possible enhanced inflammation, vasoconstriction, and thrombosis[4]. SP activates platelets, causes endothelial damage, and directly promotes arterial and venous thrombosis[5]. Moreover, immune system cells that have taken up the lipid nanoparticles (LNPs) then release them back into the circulation with elevated numbers of exosomes containing SP and microRNAs that play a role in inducing a signaling response in recipient cells at distant sites, resulting in severe inflammatory consequences[5]. Further, long term cancer control may be jeopardized in those injected with mRNA COVID-19 vaccines because of IRF7 and IRF9 suppression[5]. There is a distinct potential of a causal link between SARS-CoV-2 mRNA vaccination and neurodegenerative disease, myocarditis, immune thrombocytopenia, Bell's palsy, liver disease, impaired adaptive immunity, impaired DNA damage response and tumorigenesis[5].

These findings are supported by the recent discovery that repeated COVID-19 vaccination with mRNA-based vaccines causes production of abnormally high levels of IgG4 antibodies which can lead to immune tolerance to SP, immune suppression, and promote the development of autoimmune diseases, myocarditis, and cancer growth[6].

Neurotoxic effects of SP may cause or contribute to the post-COVID syndrome, including headache, tinnitus, autonomic dysfunction, and small fiber neuropathy[7]. Specific to the administration of viral vector COVID-19 vaccines (AstraZeneca; Johnson and Johnson) a new clinical syndrome called vaccine-induced immune thrombotic thrombocytopenia (VITT) was identified in 2021 and characterized by the development of thromboses at atypical body sites combined with severe thrombocytopenia after vaccination[9]. The pathogenesis of this life-threatening side effect is currently unknown, though it has been proposed that VITT is caused by post-vaccination antibodies against platelet factor 4 (PF4) triggering extensive platelet activation[9]. mRNA-based vaccines rarely cause VITT, but they are associated with myocarditis, or inflammation of myocardium[10]. The mechanisms for the development of myocarditis after COVID-19 vaccination are not clear, but it has been hypothesized that it may be caused by molecular mimicry of SP and self-antigens, immune response to mRNA, and dysregulated cytokine expression[10]. In adolescents and young adults diagnosed with post-mRNA vaccine myocarditis, free SP was detected in the blood while vaccinated controls had no circulating SP[11]. It has been demonstrated that SARS-CoV-2 spike mRNA vaccine sequences can circulate in the blood for at least 28 days after vaccination[12]. These

data indicate that adverse events may occur for an unknown period after vaccination, with SP playing an important potential etiological role.

A Freedom of Information Act (FOIA) document obtained from the Australian Government, titled Nonclinical Evaluation of BNT162b2 [mRNA] COVID-19 vaccine (COMIRNATY), shows systemic distribution of the LNPs containing mRNA after vaccine administration in rats, concluding that LNPs reached their highest concentration at the injection site, followed by the liver, spleen, adrenal glands, ovaries, and bone marrow (femur) over 48 hours[13]. This biodistribution data suggests that SP may be expressed in cells from many vital organ systems, raising significant concerns regarding the safety profile of COVID-19 vaccines. Given the identified vaccination syndromes and their possible mechanisms, the frequency of adverse event reports is expected to be high, especially given the vast number of vaccine doses administered globally.

Through May 5th, 2023, the Vaccine Adverse Events Reporting System (VAERS) contained 1,556,050 adverse event reports associated with COVID-19 vaccines, including 35,324 deaths, 26,928 myocarditis and pericarditis, 19,546 heart attacks, and 8,701 thrombocytopenia reports[14]. If the alarmingly high number of reported deaths are indeed causally linked to COVID-19 vaccination, the

implications could be immense, including: the complete withdrawal of all COVID-19 vaccines from the global market, suspension of all remaining COVID-19 vaccine mandates and passports, loss of public trust in government and medical institutions, investigations and inquiries into the censorship, silencing and persecution of doctors and scientists who raised these concerns, and compensation for those who were harmed as a result of the administration of COVID-19 vaccines. Using VAERS data alone to establish a causal link between COVID-19 vaccination and death, however, is not possible due to many limitations and confounding factors.

Autopsies are one of the most powerful diagnostic tools in medicine to establish cause of death and clarify the pathophysiology of disease[15]. COVID-19 vaccines, with plausible mechanisms of injury to the human body and a substantial number of adverse event reports, represent an exposure that may be causally linked to death in some cases. The purpose of this systematic review is to investigate possible causal links between COVID-19 vaccine administration and death using autopsies and post-mortem analysis.

Methods

We performed a systematic review of all published autopsy and necropsy reports relating to COVID-19 vaccination through May 18th, 2023. All autopsy studies that include COVID-19 vaccines as a possible cause of death were included. All necropsy (analysis of dead tissue) studies that include COVID-19 vaccines as a possible cause of organ death were included. No other restrictions were imposed. The following databases were used: PubMed and ScienceDirect. The following keywords were used: 'COVID-19 Vaccine', 'SARS-CoV-2 Vaccine', 'COVID Vaccination', and 'Post-mortem', 'Autopsy', or 'Necropsy'. All selected studies were screened for relevant literature contained in their references. Because the state of knowledge has advanced since the time of the original publications, we performed a contemporary review: three physicians (RH, WM, PAM) with experience in death adjudication and anatomical/clinical pathology independently reviewed the available information of each case and determined whether or not COVID-19 vaccination was the direct cause or contributed significantly to the mechanism of death described. Agreement was reached when two or more physicians adjudicated the case concordantly. For the study by Chaves[20], only cardiovascular and hematological system related cases were adjudicated as being linked to the vaccine due to a high probability of COVID-19 vaccination contributing to death and missing individual case information for the other individuals. Given the presence of some missing data, we used all available

information to calculate the descriptive statistics. Estimated age (exact age not given) and inferred time from last vaccine administration to death (no definitive time given) were excluded from calculations.

Results

A database search yielded 678 studies that had potential to meet our inclusion criterion. 562 duplicates were screened out. Out of the remaining 116 papers, 36 met our specified inclusion criterion. Through further analysis of references, we located 18 additional papers, with 8 of them meeting our inclusion criterion. In total, we found 44 studies that contained autopsy or necropsy reports of COVID-19 vaccinees (Figure 1).

Table 1 summarizes the 44 studies[16-59]. There were a total of 325 autopsy cases and 1 necropsy case (heart). The mean age of death was 70.4 years and there were 139 females (42.6%). Most received a Pfizer/BioNTech vaccine (41%), followed by Sinovac (37%), AstraZeneca (13%), Moderna (7%), Johnson & Johnson (1%), and Sinopharm (1%).

The cardiovascular system was most frequently implicated (53%), followed by hematological (17%), respiratory (8%), multiple organ systems (7%),

neurological (4%), immunological (3%), and gastrointestinal (1%). In 7% of cases, the cause of death was either unknown, non-natural (drowning, head injury, etc.) or infection (Figure 2). One organ system was affected in 302 cases, two in 3 cases, three in 8 cases, and four or more in 13 cases (Figure 3).

The number of days from vaccination until death was 14.3 (mean), 3 (median) irrespective of dose, 7.8 (mean), 3 (median) after one dose, 23.2 (mean), 2 (median) after two doses, and 5.7 (mean), 2 (median) after three doses. The distribution of days from last vaccine administration to death is highly right skewed, showing that most of the deaths occurred within a week from last vaccination (Figure 4). 240 deaths (73.9%) were independently adjudicated by three physicians to be significantly linked to COVID-19 vaccination (Table S1). Among adjudicators, there was complete independent agreement (all three physicians) of vaccination causing or contributing to death in 203 cases (62.5%). The one necropsy case was judged to be linked to vaccination with complete agreement.

Discussion

We found 73.9% of deaths after COVID-19 vaccination were attributable to fatal vaccine injury syndromes. The cardiovascular system was by far the most

implicated organ system in death, followed by hematological, respiratory, multiple organ systems, neurological, immunological, and gastrointestinal (Figure 2), with three or more organ systems affected in 21 cases (Figure 3). The majority of deaths occurred within a week from last vaccine administration (Figure 4) and were independently adjudicated by three physicians to be significantly associated with vaccination (Table S1). These results corroborate known COVID-19 vaccine-induced syndromes and show significant, temporal associations between COVID-19 vaccination and death involving multiple organ systems, with a predominant implication of the cardiovascular and hematological systems. Criteria of causality from an epidemiological perspective have been met including biological plausibility, temporal association, internal and external validity, coherence, analogy, and reproducibility with each successive report of death after COVID-19 vaccination.

Our findings amplify concerns regarding COVID-19 vaccine adverse events and their mechanisms. SP's deleterious effects[5,6,7,8,10,11], especially on the heart[10,11], likely explains the high proportion of cardiovascular deaths seen in our study. They also highlight the involvement of multiple organ systems in some of the deaths associated with COVID-19 vaccination. This might be attributed to the Multisystem Inflammatory Syndrome (MIS) that has been detected following

COVID-19 vaccination in both children[60] and adults[61]. A possible mechanism by which MIS occurs after vaccination could be the systemic distribution of the LNPs containing mRNA after vaccine administration[13] and the consequent systemic SP expression and circulation resulting in system-wide inflammation. A significant proportion of cases were due to hematological system adverse events, which is not surprising given that VITT[62] and pulmonary embolism (PE)[63] have been reported in the literature as serious adverse events following COVID-19 vaccination. Deaths caused by adverse effects to the respiratory system were also relatively common in our review, a finding that is in line with the possibility of developing acute respiratory distress syndrome (ARDS) or drug-induced interstitial lung disease (DIILD) after COVID-19 vaccination[64,65]. Although uncommon among cases in this study, immunological[66], neurological[67], and gastrointestinal[68] adverse events can still occur after COVID-19 vaccination and, as with the cardiovascular system, may be directly or indirectly caused by the systemic expression or circulation of SP. Given the average time (14.3 days) in which cases died after vaccination, a temporal association between COVID-19 vaccination and death among most cases is further supported by the finding that SARS-CoV-2 spike mRNA vaccine sequences can circulate in the blood for at least 28 days after vaccination[12]. Most of the deployed vaccine platforms are associated with death, suggesting that they share a common feature that causes adverse effects, which is most likely SP.

The large number of COVID-19 vaccine induced deaths evaluated in this review is consistent with multiple papers that report excess mortality after vaccination. Pantazatos and Seligmann found that all-cause mortality increased 0-5 weeks post-injection in most age groups resulting in 146,000 to 187,000 vaccine-associated deaths in the United States between February and August of 2021[69]. With similar findings, Skidmore estimated that 278,000 people may have died from the COVID-19 vaccine in the United States by December 2021[70]. These concerning results were further elucidated by Aarstad and Kvitastein, who found that among 31 countries in Europe, a higher population COVID-19 vaccine uptake in 2021 was positively correlated with increased all-cause mortality in the first nine months of 2022 after controlling for alternative explanations[71]. Furthermore, excess mortality from non-COVID-19 causes has been detected in many countries since the mass vaccination programs began[72,73,74,75,76,77], suggesting a common deleterious exposure among populations. Pantazatos estimated that VAERS deaths are underreported by a factor of 20[69]. If we apply this underreporting factor to the May 5th, 2023, VAERS death report count of 35,324[14], the number of deaths in the United States alone becomes 706,480. If this extrapolated number of deaths were to be confirmed, the COVID-19 vaccines would represent the largest medical failure in human history.

In summary, we identified a large series of deaths after COVID-19 vaccination, confirmed with autopsy and necropsy, to help the medical community better understand fatal COVID-19 vaccine syndromes. The consistency seen among cases in this review with known COVID-19 vaccine adverse events, their mechanisms, and related excess death, coupled with autopsy confirmation and expert physician death adjudication, suggests there is a high likelihood of a causal link between COVID-19 vaccines and death in most cases. Even with substantial evidence, our paper cannot definitively determine causality as our paper has all the limitations of systematic reviews of previously published papers including selection bias, publication bias, and confounding variables. Further urgent investigation is required aimed at confirming our results and further elucidating the mechanisms underlying the described fatal outcomes with the goal of risk mitigation for the large numbers of individuals who have taken one or more COVID-19 vaccines.

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Conflict of Interest

Drs Alexander, Amerling, Hodkinson, Makis, McCullough, Risch, Trozzi are affiliated with and receive salary support and or hold equity positions in The

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References

1. WHO Coronavirus (COVID-19) Dashboard [Internet]. World Health Organization; [cited 2023 May 17]. Available from: https://covid19.who.int/
2. Kuter BJ, Offit PA, Poland GA. The development of COVID-19 vaccines in the United States: Why and how so fast? Vaccine. 2021 Apr 28;39(18):2491-2495. doi: 10.1016/j.vaccine.2021.03.077. Epub 2021 Mar 26. PMID: 33824043; PMCID: PMC7997594
3. Graña C, Ghosn L, Evrenoglou T, Jarde A, Minozzi S, Bergman H, Buckley BS, Probyn K, Villanueva G, Henschke N, Bonnet H, Assi R, Menon S, Marti M, Devane D, Mallon P, Lelievre JD, Askie LM, Kredo T, Ferrand G, Davidson M, Riveros C, Tovey D, Meerpohl JJ, Grasselli G, Rada G, Hróbjartsson A, Ravaud P, Chaimani A, Boutron I. Efficacy and safety of COVID-19 vaccines. Cochrane Database Syst Rev. 2022 Dec 7;12(12):CD015477. doi: 10.1002/14651858.CD015477. PMID: 36473651; PMCID: PMC9726273.
4. Trougakos IP, Terpos E, Alexopoulos H, Politou M, Paraskevis D, Scorilas A, Kastritis E, Andreakos E, Dimopoulos MA. Adverse effects of COVID-

19 mRNA vaccines: the spike hypothesis. Trends Mol Med. 2022 Jul;28(7):542-554. doi: 10.1016/j.molmed.2022.04.007. Epub 2022 Apr 21. PMID: 35537987; PMCID: PMC9021367.

5. Seneff S, Nigh G, Kyriakopoulos AM, McCullough PA. Innate immune suppression by SARS-CoV-2 mRNA vaccinations: The role of G-quadruplexes, exosomes, and MicroRNAs. Food Chem Toxicol. 2022 Jun;164:113008. doi: 10.1016/j.fct.2022.113008. Epub 2022 Apr 15. PMID: 35436552; PMCID: PMC9012513.
6. Uversky VN, Redwan EM, Makis W, Rubio-Casillas A. IgG4 Antibodies Induced by Repeated Vaccination May Generate Immune Tolerance to the SARS-CoV-2 Spike Protein. Vaccines (Basel). 2023 May 17;11(5):991. doi: 10.3390/vaccines11050991. PMID: 37243095; PMCID: PMC10222767.
7. Theoharides TC. Could SARS-CoV-2 Spike Protein Be Responsible for Long-COVID Syndrome? Mol Neurobiol. 2022 Mar;59(3):1850-1861. doi: 10.1007/s12035-021-02696-0. Epub 2022 Jan 13. PMID: 35028901; PMCID: PMC8757925.
8. Theoharides TC, Conti P. Be aware of SARS-CoV-2 spike protein: There is more than meets the eye. J Biol Regul Homeost Agents. 2021 May-Jun;35(3):833-838. doi: 10.23812/THEO_EDIT_3_21. PMID: 34100279.

9. Aleem A, Nadeem AJ. Coronavirus (COVID-19) Vaccine-Induced Immune Thrombotic Thrombocytopenia (VITT). 2022 Oct 3. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan–. PMID: 34033367.

10. Bozkurt B, Kamat I, Hotez PJ. Myocarditis With COVID-19 mRNA Vaccines. Circulation. 2021 Aug 10;144(6):471-484. doi: 10.1161/CIRCULATIONAHA.121.056135. Epub 2021 Jul 20. PMID: 34281357; PMCID: PMC8340726.

11. Yonker LM, Swank Z, Bartsch YC, Burns MD, Kane A, Boribong BP, Davis JP, Loiselle M, Novak T, Senussi Y, Cheng CA, Burgess E, Edlow AG, Chou J, Dionne A, Balaguru D, Lahoud-Rahme M, Arditi M, Julg B, Randolph AG, Alter G, Fasano A, Walt DR. Circulating Spike Protein Detected in Post-COVID-19 mRNA Vaccine Myocarditis. Circulation. 2023 Mar 14;147(11):867-876. doi: 10.1161/CIRCULATIONAHA.122.061025. Epub 2023 Jan 4. PMID: 36597886; PMCID: PMC10010667.

12. Castruita JAS, Schneider UV, Mollerup S, Leineweber TD, Weis N, Bukh J, Pedersen MS, Westh H. SARS-CoV-2 spike mRNA vaccine sequences circulate in blood up to 28 days after COVID-19 vaccination. APMIS. 2023 Mar;131(3):128-132. doi: 10.1111/apm.13294. Epub 2023 Jan 29. PMID: 36647776; PMCID: PMC10107710.

13. Nonclinical Evaluation of BNT162b2 [mRNA] COVID-19 vaccine (COMIRNATY) [Internet]. Australian Government Department of Health - Therapeutic Goods Administration; 2021 [cited 2023 May 23]. Available from: https://www.tga.gov.au/sites/default/files/foi-2389-06.pdf

14. Vaccine Adverse Event Reporting System (VAERS) [online]. Available at: https://vaers.hhs.gov.

15. Scarl R, Parkinson B, Arole V, Hardy T, Allenby P. The hospital autopsy: the importance in keeping autopsy an option. Autopsy Case Rep. 2022 Feb 17;12:e2021333. doi: 10.4322/acr.2021.333. PMID: 35252044; PMCID: PMC8890781.

16. Hojberg Y, Abdeljaber M, Prahlow JA. Generalized Eosinophilia Following Moderna COVID-19 Vaccine Administration: A Case Report. Acad Forensic Pathol. 2023 Mar;13(1):9-15. doi: 10.1177/19253621231157933. Epub 2023 Mar 28. PMID: 37091194; PMCID: PMC10119868.

17. Nushida H, Ito A, Kurata H, Umemoto H, Tokunaga I, Iseki H, Nishimura A. A case of fatal multi-organ inflammation following COVID-19 vaccination. Leg Med (Tokyo). 2023 Mar 20;63:102244. doi: 10.1016/j.legalmed.2023.102244. Epub ahead of print. PMID: 36990036; PMCID: PMC10027302.

18. Jeon YH, Choi S, Park JH, Lee JK, Yeo NS, Lee S, Suh YL. Sudden Death Associated With Possible Flare-Ups of Multiple Sclerosis After COVID-19 Vaccination and Infection: A Case Report and Literature Review. J Korean Med Sci. 2023 Mar 13;38(10):e78. doi: 10.3346/jkms.2023.38.e78. PMID: 36918031; PMCID: PMC10010908.

19. Esposito M, Cocimano G, Vanaria F, Sessa F, Salerno M. Death from COVID-19 in a Fully Vaccinated Subject: A Complete Autopsy Report. Vaccines (Basel). 2023 Jan 9;11(1):142. doi: 10.3390/vaccines11010142. PMID: 36679987; PMCID: PMC9865400.

20. Chaves JJ, Bonilla JC, Chaves-Cabezas V, Castro A, Polo JF, Mendoza O, Correa-Rodríguez J, Piedrahita AC, Romero-Fandiño IA, Caro MV, González AC, Sánchez LK, Murcia F, Márquez G, Benavides A, Quiroga MDP, López J, Parra-Medina R. A postmortem study of patients vaccinated for SARS-CoV-2 in Colombia. Rev Esp Patol. 2023 Jan-Mar;56(1):4-9. doi: 10.1016/j.patol.2022.09.003. Epub 2022 Oct 31. PMID: 36599599; PMCID: PMC9618417.

21. Mörz M. A Case Report: Multifocal Necrotizing Encephalitis and Myocarditis after BNT162b2 mRNA Vaccination against COVID-19. Vaccines (Basel). 2022 Oct 1;10(10):1651. doi: 10.3390/vaccines10101651. PMID: 36298516; PMCID: PMC9611676.

22. Alunni V, Bernardi C, Chevalier N, Cabusat C, Quatrehomme G, Torrents J, Biglia E, Gaillard Y, Drici MD. Postmortem PF4 antibodies confirm a rare case of thrombosis thrombocytopenia syndrome associated with ChAdOx1 nCoV-19 anti-COVID vaccination. Int J Legal Med. 2023 Mar;137(2):487-492. doi: 10.1007/s00414-022-02910-1. Epub 2022 Oct 27. PMID: 36289074; PMCID: PMC9607767.

23. Takahashi M, Kondo T, Yamasaki G, Sugimoto M, Asano M, Ueno Y, Nagasaki Y. An autopsy case report of aortic dissection complicated with histiolymphocytic pericarditis and aortic inflammation after mRNA COVID-19 vaccination. Leg Med (Tokyo). 2022 Nov;59:102154. doi: 10.1016/j.legalmed.2022.102154. Epub 2022 Sep 29. PMID: 36191411; PMCID: PMC9519380.

24. Murata K, Nakao N, Ishiuchi N, Fukui T, Katsuya N, Fukumoto W, Oka H, Yoshikawa N, Nagao T, Namera A, Kakimoto N, Oue N, Awai K, Yoshimoto K, Nagao M. Four cases of cytokine storm after COVID-19 vaccination: Case report. Front Immunol. 2022 Aug 15;13:967226. doi: 10.3389/fimmu.2022.967226. PMID: 36045681; PMCID: PMC9420842.

25. Satomi H, Katano H, Kanno H, Kobayashi M, Ohkuma Y, Hashidume N, Usui T, Tsukada S, Ito I. An autopsy case of fulminant myocarditis after severe acute respiratory syndrome coronavirus 2 vaccine inoculation. Pathol

Int. 2022 Oct;72(10):519-524. doi: 10.1111/pin.13267. Epub 2022 Aug 30. PMID: 36040128; PMCID: PMC9537995.

26. Suzuki H, Ro A, Takada A, Saito K, Hayashi K. Autopsy findings of post-COVID-19 vaccination deaths in Tokyo Metropolis, Japan, 2021. Leg Med (Tokyo). 2022 Nov;59:102134. doi: 10.1016/j.legalmed.2022.102134. Epub 2022 Aug 20. PMID: 36037554; PMCID: PMC9392553.

27. Mele F, Tafuri S, Stefanizzi P, D Amati A, Calvano M, Leonardelli M, Macorano E, Duma S, De Gabriele G, Introna F, De Donno A. Cerebral venous sinus thrombosis after COVID-19 vaccination and congenital deficiency of coagulation factors: Is there a correlation? Hum Vaccin Immunother. 2022 Nov 30;18(6):2095166. doi: 10.1080/21645515.2022.2095166. Epub 2022 Jul 27. PMID: 35895937; PMCID: PMC9746424.

28. Yoshimura Y, Sasaki H, Miyata N, Miyazaki K, Okudela K, Tateishi Y, Hayashi H, Kawana-Tachikawa A, Iwashita H, Maeda K, Ihama Y, Hatayama Y, Ryo A, Tachikawa N. An autopsy case of COVID-19-like acute respiratory distress syndrome after mRNA-1273 SARS-CoV-2 vaccination. Int J Infect Dis. 2022 Aug;121:98-101. doi: 10.1016/j.ijid.2022.04.057. Epub 2022 Apr 30. PMID: 35500794; PMCID: PMC9054706.

29. Roncati L, Manenti A, Corsi L. A Three-Case Series of Thrombotic Deaths in Patients over 50 with Comorbidities Temporally after modRNA COVID-19 Vaccination. Pathogens. 2022 Apr 3;11(4):435. doi: 10.3390/pathogens11040435. PMID: 35456110; PMCID: PMC9032304.

30. Kang DH, Na JY, Yang JH, Moon SH, Kim SH, Jung JJ, Cha HJ, Ahn JH, Park YW, Cho SY, Yu HK, Lee SH, Park MY, Kim JW, Byun JH. Fulminant Giant Cell Myocarditis following Heterologous Vaccination of ChAdOx1 nCoV-19 and Pfizer-BioNTech COVID-19. Medicina (Kaunas). 2022 Mar 20;58(3):449. doi: 10.3390/medicina58030449. PMID: 35334625; PMCID: PMC8950462.

31. Kamura Y, Terao T, Akao S, Kono Y, Honma K, Matsue K. Fatal thrombotic microangiopathy with rhabdomyolysis as an initial symptom after the first dose of mRNA-1273 vaccine: A case report. Int J Infect Dis. 2022 Apr;117:322-325. doi: 10.1016/j.ijid.2022.02.031. Epub 2022 Feb 18. PMID: 35189339; PMCID: PMC8853962.

32. Ishioka Y, Makiguchi T, Itoga M, Tanaka H, Taima K, Goto S, Tasaka S. Acute Exacerbation of Interstitial Lung Disease After SARS-CoV-2 Vaccination: A Case Series. Chest. 2022 Dec;162(6):e311-e316. doi: 10.1016/j.chest.2022.08.2213. PMID: 36494131; PMCID: PMC9723271.

33. Gill JR, Tashjian R, Duncanson E. Autopsy Histopathologic Cardiac Findings in 2 Adolescents Following the Second COVID-19 Vaccine Dose. Arch Pathol Lab Med. 2022 Aug 1;146(8):925-929. doi: 10.5858/arpa.2021-0435-SA. PMID: 35157759.

34. Pomara C, Salerno M, Esposito M, Sessa F, Certo F, Tripodo C, Rappa F, Barbagallo GM. Histological and immunohistochemical findings in a fatal case of thrombotic thrombocytopenia after ChAdOx1 nCov-19 vaccination. Pathol Res Pract. 2022 Mar;231:153796. doi: 10.1016/j.prp.2022.153796. Epub 2022 Feb 4. PMID: 35144085.

35. Yeo A, Kuek B, Lau M, Tan SR, Chan S. Post COVID-19 vaccine deaths - Singapore's early experience. Forensic Sci Int. 2022 Jan 19;332:111199. doi: 10.1016/j.forsciint.2022.111199. Epub ahead of print. PMID: 35078041; PMCID: PMC8767909.

36. Ameratunga R, Woon ST, Sheppard MN, Garland J, Ondruschka B, Wong CX, Stewart RAH, Tatley M, Stables SR, Tse RD. First Identified Case of Fatal Fulminant Necrotizing Eosinophilic Myocarditis Following the Initial Dose of the Pfizer-BioNTech mRNA COVID-19 Vaccine (BNT162b2, Comirnaty): an Extremely Rare Idiosyncratic Hypersensitivity Reaction. J Clin Immunol. 2022 Apr;42(3):441-447. doi: 10.1007/s10875-021-01187-0. Epub 2022 Jan 3. PMID: 34978002; PMCID: PMC8720536.

37. Günther A, Brämer D, Pletz MW, Kamradt T, Baumgart S, Mayer TE, Baier M, Autsch A, Mawrin C, Schönborn L, Greinacher A, Thiele T. Complicated Long Term Vaccine Induced Thrombotic Immune Thrombocytopenia-A Case Report. Vaccines (Basel). 2021 Nov 17;9(11):1344. doi: 10.3390/vaccines9111344. PMID: 34835275; PMCID: PMC8622649.

38. Permezel F, Borojevic B, Lau S, de Boer HH. Acute disseminated encephalomyelitis (ADEM) following recent Oxford/AstraZeneca COVID-19 vaccination. Forensic Sci Med Pathol. 2022 Mar;18(1):74-79. doi: 10.1007/s12024-021-00440-7. Epub 2021 Nov 4. PMID: 34735684; PMCID: PMC8567127.

39. Choi S, Lee S, Seo JW, Kim MJ, Jeon YH, Park JH, Lee JK, Yeo NS. Myocarditis-induced Sudden Death after BNT162b2 mRNA COVID-19 Vaccination in Korea: Case Report Focusing on Histopathological Findings. J Korean Med Sci. 2021 Oct 18;36(40):e286. doi: 10.3346/jkms.2021.36.e286. PMID: 34664804; PMCID: PMC8524235.

40. Schneider J, Sottmann L, Greinacher A, Hagen M, Kasper HU, Kuhnen C, Schlepper S, Schmidt S, Schulz R, Thiele T, Thomas C, Schmeling A. Postmortem investigation of fatalities following vaccination with COVID-19 vaccines. Int J Legal Med. 2021 Nov;135(6):2335-2345. doi:

10.1007/s00414-021-02706-9. Epub 2021 Sep 30. PMID: 34591186; PMCID: PMC8482743.

41. Verma AK, Lavine KJ, Lin CY. Myocarditis after Covid-19 mRNA Vaccination. N Engl J Med. 2021 Sep 30;385(14):1332-1334. doi: 10.1056/NEJMc2109975. Epub 2021 Aug 18. PMID: 34407340; PMCID: PMC8385564.

42. Wiedmann M, Skattør T, Stray-Pedersen A, Romundstad L, Antal EA, Marthinsen PB, Sørvoll IH, Leiknes Ernstsen S, Lund CG, Holme PA, Johansen TO, Brunborg C, Aamodt AH, Schultz NH, Skagen K, Skjelland M. Vaccine Induced Immune Thrombotic Thrombocytopenia Causing a Severe Form of Cerebral Venous Thrombosis With High Fatality Rate: A Case Series. Front Neurol. 2021 Jul 30;12:721146. doi: 10.3389/fneur.2021.721146. PMID: 34393988; PMCID: PMC8363077.

43. Pomara C, Sessa F, Ciaccio M, Dieli F, Esposito M, Giammanco GM, Garozzo SF, Giarratano A, Prati D, Rappa F, Salerno M, Tripodo C, Mannucci PM, Zamboni P. COVID-19 Vaccine and Death: Causality Algorithm According to the WHO Eligibility Diagnosis. Diagnostics (Basel). 2021 May 26;11(6):955. doi: 10.3390/diagnostics11060955. PMID: 34073536; PMCID: PMC8229116.

44. Althaus K, Möller P, Uzun G, Singh A, Beck A, Bettag M, Bösmüller H, Guthoff M, Dorn F, Petzold GC, Henkes H, Heyne N, Jumaa H, Kreiser K, Limpach C, Luz B, Maschke M, Müller JA, Münch J, Nagel S, Pötzsch B, Müller J, Schlegel C, Viardot A, Bäzner H, Wolf M, Pelzl L, Warm V, Willinek WA, Steiner J, Schneiderhan-Marra N, Vollherbst D, Sachs UJ, Fend F, Bakchoul T. Antibody-mediated procoagulant platelets in SARS-CoV-2-vaccination associated immune thrombotic thrombocytopenia. Haematologica. 2021 Aug 1;106(8):2170-2179. doi: 10.3324/haematol.2021.279000. PMID: 34011137; PMCID: PMC8327736.

45. Edler C, Klein A, Schröder AS, Sperhake JP, Ondruschka B. Deaths associated with newly launched SARS-CoV-2 vaccination (Comirnaty®). Leg Med (Tokyo). 2021 Jul;51:101895. doi: 10.1016/j.legalmed.2021.101895. Epub 2021 Apr 17. PMID: 33895650; PMCID: PMC8052499.

46. Hansen T, Titze U, Kulamadayil-Heidenreich NSA, Glombitza S, Tebbe JJ, Röcken C, Schulz B, Weise M, Wilkens L. First case of postmortem study in a patient vaccinated against SARS-CoV-2. Int J Infect Dis. 2021 Jun;107:172-175. doi: 10.1016/j.ijid.2021.04.053. Epub 2021 Apr 16. PMID: 33872783; PMCID: PMC8051011.

47. Baronti A, Gentile F, Manetti AC, Scatena A, Pellegrini S, Pucci A, Franzini M, Castiglione V, Maiese A, Giannoni A, Pistello M, Emdin M, Aquaro GD, Di Paolo M. Myocardial Infarction Following COVID-19 Vaccine Administration: *Post Hoc, Ergo Propter Hoc*? Viruses. 2022 Jul 27;14(8):1644. doi: 10.3390/v14081644. PMID: 36016266; PMCID: PMC9413746.

48. Ittiwut C, Mahasirimongkol S, Srisont S, Ittiwut R, Chockjamsai M, Durongkadech P, Sawaengdee W, Khunphon A, Larpadisorn K, Wattanapokayakit S, Wetchaphanphesat S, Arunotong S, Srimahachota S, Pittayawonganon C, Thammawijaya P, Sutdan D, Doungngern P, Khongphatthanayothin A, Kerr SJ, Shotelersuk V. Genetic basis of sudden death after COVID-19 vaccination in Thailand. Heart Rhythm. 2022 Aug 5;19(11):1874–9. doi: 10.1016/j.hrthm.2022.07.019. Epub ahead of print. PMID: 35934244; PMCID: PMC9352648.

49. Greinacher A, Thiele T, Warkentin TE, Weisser K, Kyrle PA, Eichinger S. Thrombotic Thrombocytopenia after ChAdOx1 nCov-19 Vaccination. N Engl J Med. 2021 Jun 3;384(22):2092-2101. doi: 10.1056/NEJMoa2104840. Epub 2021 Apr 9. PMID: 33835769; PMCID: PMC8095372.

50. Mauriello A, Scimeca M, Amelio I, Massoud R, Novelli A, Di Lorenzo F, Finocchiaro S, Cimino C, Telesca R, Chiocchi M, Sun Q, Wang Y, Shi Y,

Novelli G, Melino G. Thromboembolism after COVID-19 vaccine in patients with preexisting thrombocytopenia. Cell Death Dis. 2021 Aug 3;12(8):762. doi: 10.1038/s41419-021-04058-z. PMID: 34344867; PMCID: PMC8328816.

51. Bjørnstad-Tuveng TH, Rudjord A, Anker P. Fatal cerebral haemorrhage after COVID-19 vaccine. Tidsskr Nor Laegeforen. 2021 Apr 29;141. English, Norwegian. doi: 10.4045/tidsskr.21.0312. PMID: 33928772.

52. Scully M, Singh D, Lown R, Poles A, Solomon T, Levi M, Goldblatt D, Kotoucek P, Thomas W, Lester W. Pathologic Antibodies to Platelet Factor 4 after ChAdOx1 nCoV-19 Vaccination. N Engl J Med. 2021 Jun 10;384(23):2202-2211. doi: 10.1056/NEJMoa2105385. Epub 2021 Apr 16. PMID: 33861525; PMCID: PMC8112532.

53. Choi GJ, Baek SH, Kim J, Kim JH, Kwon GY, Kim DK, Jung YH, Kim S. Fatal Systemic Capillary Leak Syndrome after SARS-CoV-2Vaccination in Patient with Multiple Myeloma. Emerg Infect Dis. 2021 Nov;27(11):2973-2975. doi: 10.3201/eid2711.211723. Epub 2021 Aug 30. PMID: 34459725; PMCID: PMC8544977.

54. Schwab C, Domke LM, Hartmann L, Stenzinger A, Longerich T, Schirmacher P. Autopsy-based histopathological characterization of myocarditis after anti-SARS-CoV-2-vaccination. Clin Res Cardiol. 2023

Mar;112(3):431-440. doi: 10.1007/s00392-022-02129-5. Epub 2022 Nov 27. PMID: 36436002; PMCID: PMC9702955.

55. Hirschbühl K, Schaller T, Märkl B, Claus R, Sipos E, Rentschler L, Maccagno A, Grosser B, Kling E, Neidig M, Kröncke T, Spring O, Braun G, Bösmüller H, Seidl M, Esposito I, Pablik J, Hilsenbeck J, Boor P, Beer M, Dintner S, Wylezich C. High viral loads: what drives fatal cases of COVID-19 in vaccinees? - an autopsy study. Mod Pathol. 2022 Aug;35(8):1013-1021. doi: 10.1038/s41379-022-01069-9. Epub 2022 Apr 1. PMID: 35365771; PMCID: PMC8974809.

56. Hoshino N, Yanase M, Ichiyasu T, Kuwahara K, Kawai H, Muramatsu T, Ishii H, Tsukamoto T, Morimoto SI, Izawa H. An autopsy case report of fulminant myocarditis: Following mRNA COVID-19 vaccination. J Cardiol Cases. 2022 Dec;26(6):391-394. doi: 10.1016/j.jccase.2022.06.006. Epub 2022 Jul 4. PMID: 35812802; PMCID: PMC9250935.

57. Colombo D, Del Nonno F, Marchioni L, Lalle E, Gallì P, Vaia F, Falasca L. Autopsies Revealed Pathological Features of COVID-19 in Unvaccinated vs. Vaccinated Patients. Biomedicines. 2023 Feb 14;11(2):551. doi: 10.3390/biomedicines11020551. PMID: 36831087; PMCID: PMC9953314.

58. Mosna K, Vadkerti P, Papp L, Palkovic M, Janega P, Babal P. Guillain-Barré syndrome with lethal outcome following covid-19 vaccination - case

report supported by autopsy examination. The Open Neurology Journal. 2022 Mar 10;16(1). doi:10.2174/1874205x-v16-e2207270

59. Kaimori R, Nishida H, Uchida T, Tamura M, Kuroki K, Murata K, Hatakeyama K, Ikeda Y, Amemiya K, Nishizono A, Daa T, Mori S. Histopathologically TMA-like distribution of multiple organ thromboses following the initial dose of the BNT162b2 mRNA vaccine (Comirnaty, Pfizer/BioNTech): an autopsy case report. Thromb J. 2022 Oct 6;20(1):61. doi: 10.1186/s12959-022-00418-7. PMID: 36203145; PMCID: PMC9540301.

60. Wangu Z, Swartz H, Doherty M. Multisystem inflammatory syndrome in children (MIS-C) possibly secondary to COVID-19 mRNA vaccination. BMJ Case Rep. 2022 Mar 30;15(3):e247176. doi: 10.1136/bcr-2021-247176. PMID: 35354564; PMCID: PMC8968554.

61. Ehikhametalor K, Deans-Minott J, Duncan JP. Multisystem Inflammatory Syndrome in Adults (MIS-A) After COVID-19 Infection and Recent Vaccination with Recombinant Adenoviral Vector Encoding the Spike Protein Antigen of SARS-CoV-2 (ChAdOx1 nCoV-19, Vaxzevria). J Intensive Care Med. 2023 Feb;38(2):232-237. doi: 10.1177/08850666221121589. Epub 2022 Aug 17. PMID: 35979616; PMCID: PMC9389272.

62. Zidan A, Noureldin A, Kumar SA, Elsebaie A, Othman M. COVID-19 Vaccine-Associated Immune Thrombosis and Thrombocytopenia (VITT): Diagnostic Discrepancies and Global Implications. Semin Thromb Hemost. 2023 Feb;49(1):9-14. doi: 10.1055/s-0042-1759684. Epub 2023 Jan 5. PMID: 36603593.

63. Ifeanyi N, Chinenye N, Oladiran O, David E, Mmonu C, Ogbonna-Nwosu C. Isolated pulmonary embolism following COVID vaccination: 2 case reports and a review of post-acute pulmonary embolism complications and follow-up. J Community Hosp Intern Med Perspect. 2021 Nov 15;11(6):877-879. doi: 10.1080/20009666.2021.1990825. PMID: 34804412; PMCID: PMC8604520.

64. Abraham B, Mohammed Saeed H, Azeez Pasha SA. Acute respiratory distress syndrome secondary to COVID-19 mRNA vaccine administration in a pregnant woman: A case report. Qatar Med J. 2022 Aug 9;2022(3):40. doi: 10.5339/qmj.2022.40. PMID: 35974885; PMCID: PMC9372495.

65. Yoshifuji A, Ishioka K, Masuzawa Y, Suda S, Murata S, Uwamino Y, Fujino M, Miyahara H, Hasegawa N, Ryuzaki M, Hoshino H, Sekine K. COVID-19 vaccine induced interstitial lung disease. J Infect Chemother. 2022 Jan;28(1):95-98. doi: 10.1016/j.jiac.2021.09.010. Epub 2021 Sep 20. PMID: 34580010; PMCID: PMC8450284.

66. Chen Y, Xu Z, Wang P, Li XM, Shuai ZW, Ye DQ, Pan HF. New-onset autoimmune phenomena post-COVID-19 vaccination. Immunology. 2022 Apr;165(4):386-401. doi: 10.1111/imm.13443. Epub 2022 Jan 7. PMID: 34957554.

67. Hosseini R, Askari N. A review of neurological side effects of COVID-19 vaccination. Eur J Med Res. 2023 Feb 25;28(1):102. doi: 10.1186/s40001-023-00992-0. PMID: 36841774; PMCID: PMC9959958.

68. Ajmera K, Bansal R, Wilkinson H, Goyal L. Gastrointestinal Complications of COVID-19 Vaccines. Cureus. 2022 Apr 12;14(4):e24070. doi: 10.7759/cureus.24070. PMID: 35573556; PMCID: PMC9097558.

69. Pantazatos S, Seligmann H. COVID vaccination and age-stratified all-cause mortality risk. Research Gate 2021 Oct 26. Epub Oct 26. DOI: 10.13140/RG.2.2.28257.43366

70. Skidmore M. The role of social circle COVID-19 illness and vaccination experiences in COVID-19 vaccination decisions: an online survey of the United States population. BMC Infect Dis. 2023 Jan 24;23(1):51. doi: 10.1186/s12879-023-07998-3. Retraction in: BMC Infect Dis. 2023 Apr 11;23(1):223. PMID: 36694131; PMCID: PMC9872073.

71. Aarstad, J.; Kvitastein, O.A. Is there a Link between the 2021 COVID-19 Vaccination Uptake in Europe and 2022 Excess All-Cause Mortality?.

Preprints.org 2023, 2023020350. https://doi.org/10.20944/preprints202302.0350.v1

72. Beesoon S, Bakal JA, Youngson E, Williams KP, Berzins SA, Brindle ME, Joffe AM. Excess deaths during the COVID-19 pandemic in Alberta, Canada. IJID Reg. 2022 Dec;5:62-67. doi: 10.1016/j.ijregi.2022.08.011. Epub 2022 Aug 30. PMID: 36060856; PMCID: PMC9424127.

73. Todd M, Scheeres A. Excess Mortality From Non-COVID-19 Causes During the COVID-19 Pandemic in Philadelphia, Pennsylvania, 2020-2021. Am J Public Health. 2022 Dec;112(12):1800-1803. doi: 10.2105/AJPH.2022.307096. PMID: 36383938; PMCID: PMC9670212.

74. Karlinsky A, Kobak D. The World Mortality Dataset: Tracking excess mortality across countries during the COVID-19 pandemic. medRxiv [Preprint]. 2021 Jun 4:2021.01.27.21250604. doi: 10.1101/2021.01.27.21250604. Update in: Elife. 2021 Jun 30;10: PMID: 33532789; PMCID: PMC7852240.

75. COVID-19 Excess Mortality Collaborators. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020-21. Lancet. 2022 Apr 16;399(10334):1513-1536. doi: 10.1016/S0140-6736(21)02796-3. Epub 2022 Mar 10. Erratum in: Lancet. 2022 Apr 16;399(10334):1468. PMID: 35279232; PMCID: PMC8912932.

76. Msemburi W, Karlinsky A, Knutson V, Aleshin-Guendel S, Chatterji S, Wakefield J. The WHO estimates of excess mortality associated with the COVID-19 pandemic. Nature. 2023 Jan;613(7942):130-137. doi: 10.1038/s41586-022-05522-2. Epub 2022 Dec 14. PMID: 36517599; PMCID: PMC9812776.

77. Shang W, Wang Y, Yuan J, Guo Z, Liu J, Liu M. Global Excess Mortality during COVID-19 Pandemic: A Systematic Review and Meta-Analysis. Vaccines (Basel). 2022 Oct 12;10(10):1702. doi: 10.3390/vaccines10101702. PMID: 36298567; PMCID: PMC9607451.

Figure Legends

Figure 1: Preferred Reporting Items for Systemic Reviews and Meta-Analyses (PRISMA) flow diagram detailing the study selection process.

Figure 2: Proportion of Cases by Affected Organ System

Figure 3: Number of Affected Organ Systems by Cases

Figure 4: Distribution of Time from Last Vaccine Administration to Death

Table Legends

Table 1: Characteristics of included studies on COVID-19 vaccination possibly causing death.

Supplemental Table 1: Detailed Case Information and Death Adjudications

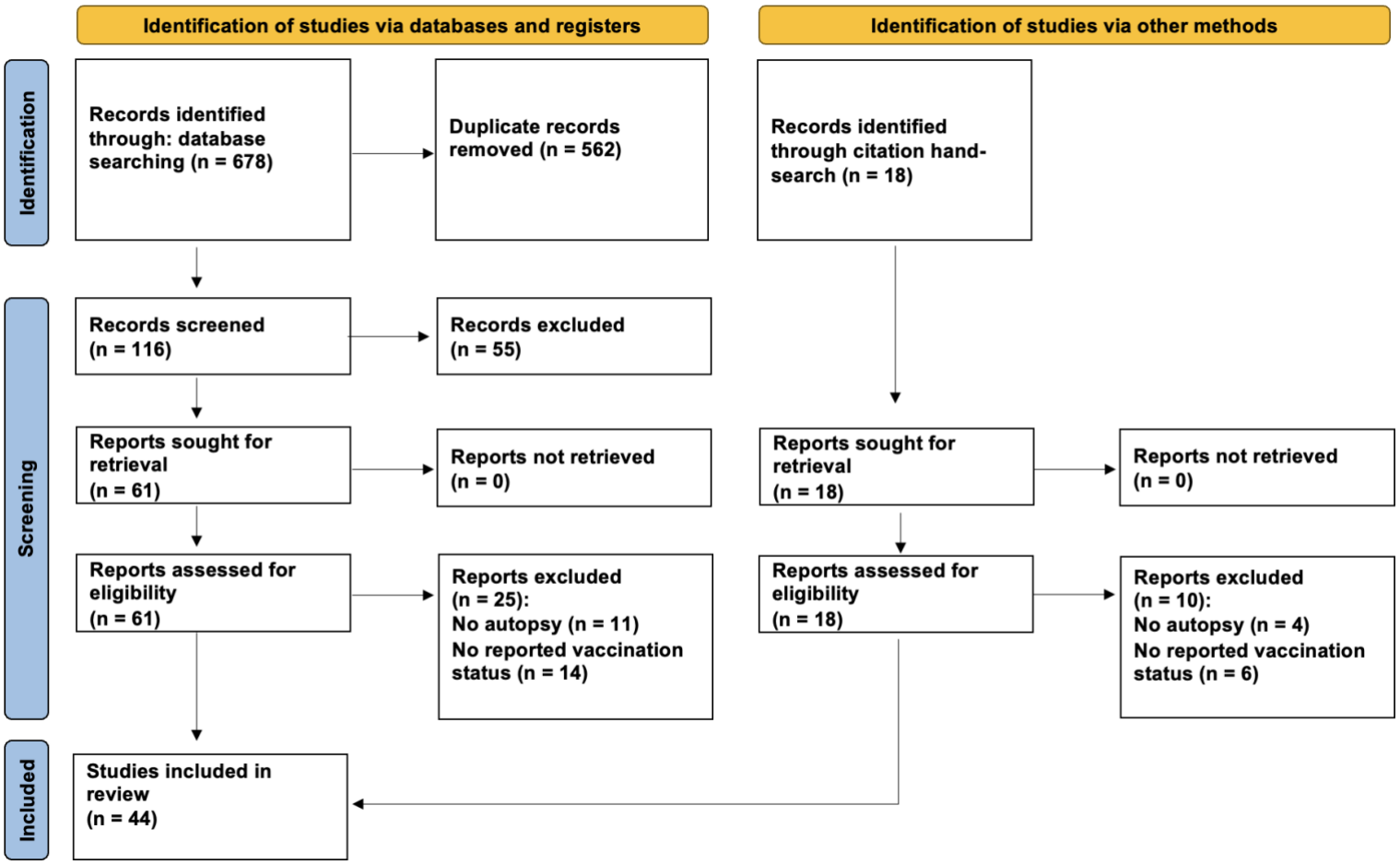
Identification of studies via databases and registers
Identification of studies via other methods
Identification
Screening
Included
Records identified through: database searching (n = 678)
Duplicate records removed (n = 562)
Records identified through citation hand-search (n = 18)
Records screened (n = 116)
Records excluded (n = 55)
Reports sought for retrieval (n = 61)
Reports not retrieved (n = 0)
Reports sought for retrieval (n = 18)
Reports not retrieved (n = 0)
Reports assessed for eligibility (n = 61)
Reports excluded (n = 25): No autopsy (n = 11) No reported vaccination status (n = 14)
Reports assessed for eligibility (n = 18)
Reports excluded (n = 10): No autopsy (n = 4) No reported vaccination status (n = 6)
Studies included in review (n = 44)

Figure 1.

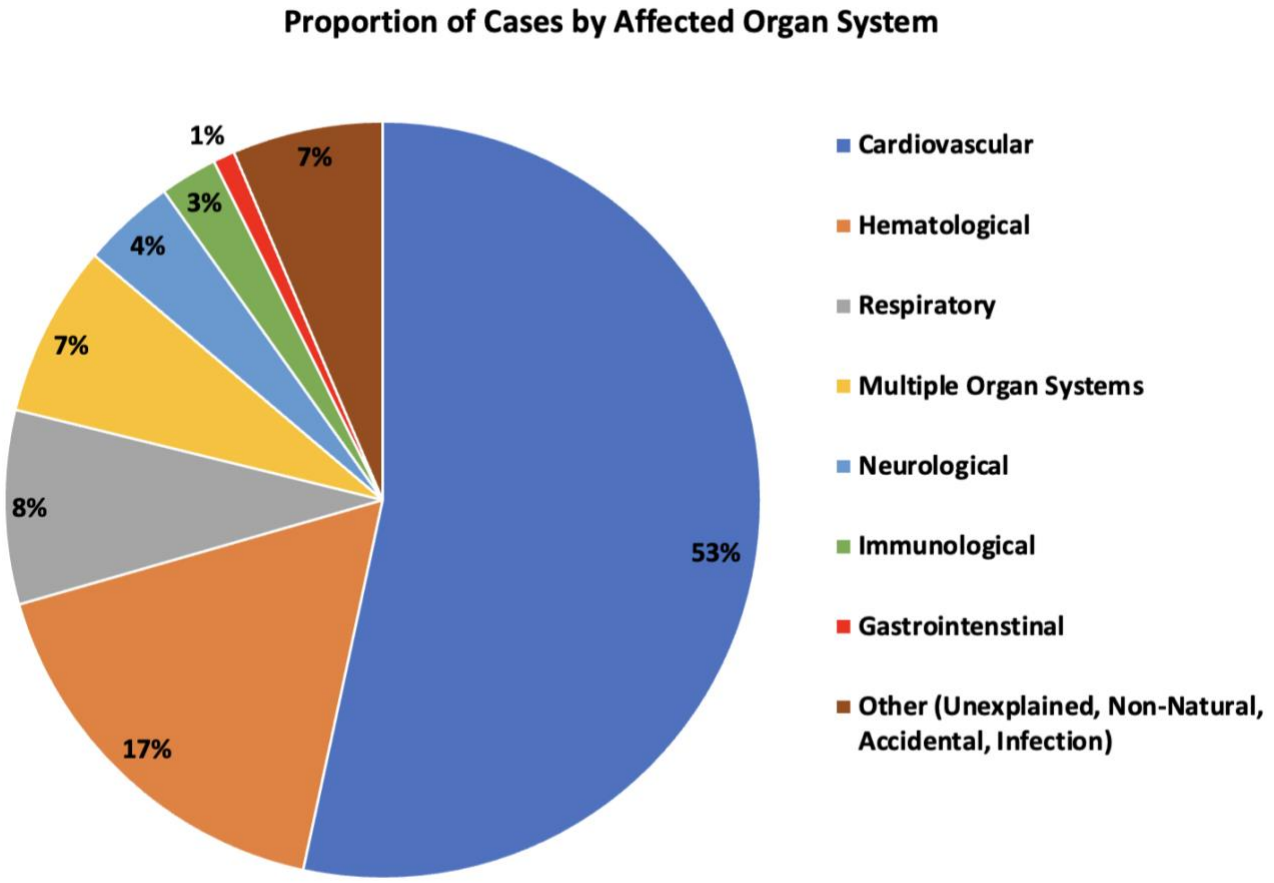
Proportion of Cases by Affected Organ System
53%
17%
8%
7%
4%
3%
1%
7%
Cardiovascular
Hematological
Respiratory
Multiple Organ Systems
Neurological
Immunological
Gastrointenstinal
Other (Unexplained, Non-Natural, Accidental, Infection)

Figure 2.

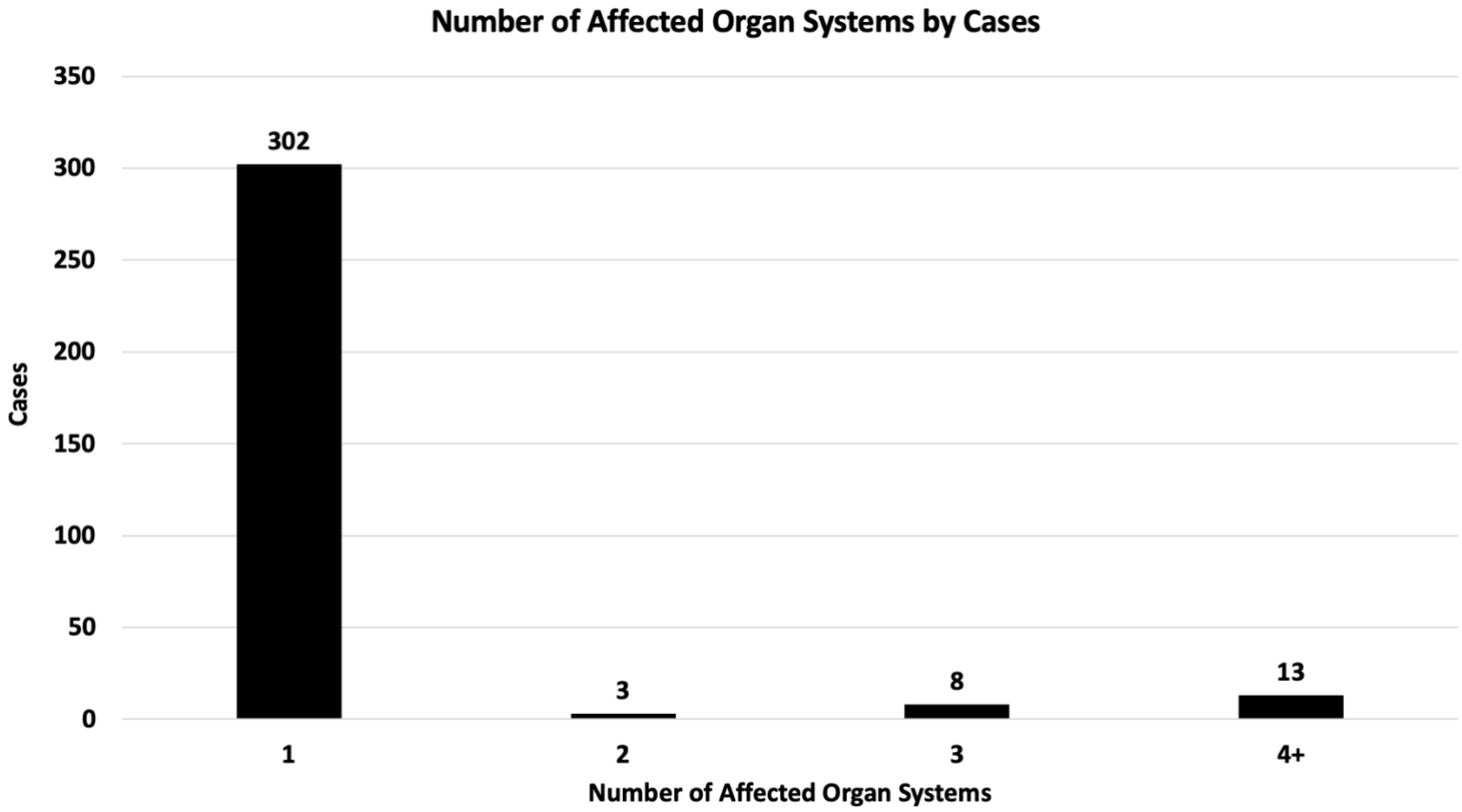
Number of Affected Organ Systems by Cases
350
300
250
200
150
100
50
0
Cases
302
3
8
13
1
2
3
4+
Number of Affected Organ Systems

Figure 3.

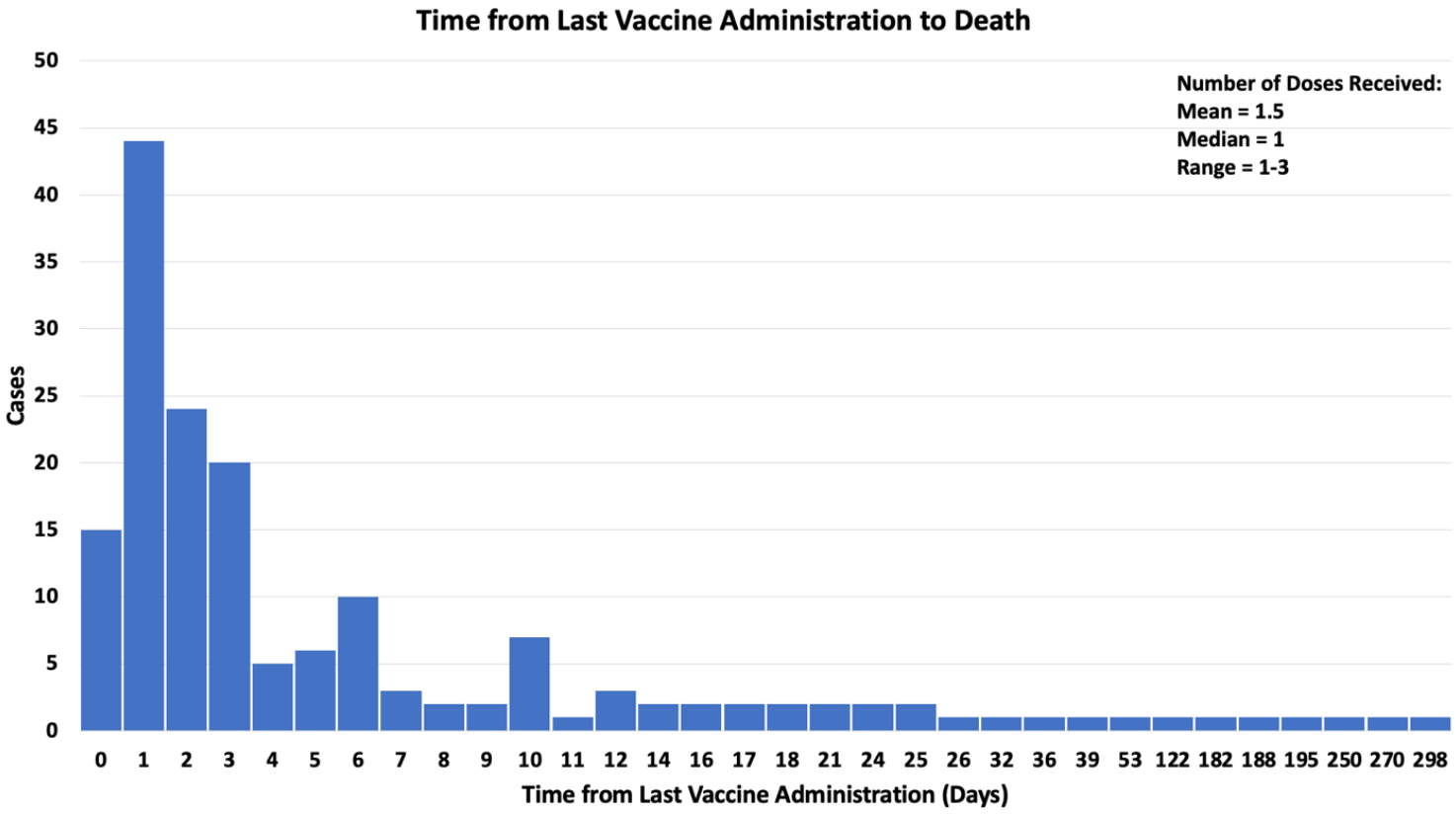
Time from Last Vaccine Administration to Death
Number of Doses Received:
Mean = 1.5
Median = 1
Range = 1-3
Cases
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 14 16 17 18 21 24 25 26 32 36 39 53 122 182 188 195 250 270 298
Time from Last Vaccine Administration (Days)

Figure 4.

AUTHOR	YEAR	COUNTRY	CASES*	AGE	SEX	VACCINE	DOSE**	DISEASE	ORGAN SYSTEM	PERIOD***	PROCEDURE
HOJBERG [16]	**2023**	**USA**	**1**			**Moderna**		**Eosinophilia**	**Immunological**	**'recent'**	**Autopsy**
NUSHIDA [17]	**2023**	**Japan**	**1**	**14**	**F**	**Pfizer**	**3**	**MIS**	**MIS**	**2 days**	**Autopsy**
JEON [18]	**2023**	**Korea**	**1**	**19**	**M**	**Pfizer**	**2**	**Multiple sclerosis**	**Neurological**	**182 days**	**Autopsy**
ESPOSITO [19]	**2023**	**Italy**	**1**	**83**	**M**	**Pfizer**	**2**	**COVID-19**	**MIS**		**Autopsy**
CHAVES [20]	**2022**	**Columbia**	**121**	**84 (mean)**	**52% F**	**Sinovac, AZ, Pfizer**	**1-2**	**SCD, MI, PE**	**Cardiovascular, Hematological**		**Autopsy**
MORZ [21]	**2022**	**Germany**	**1**	**76**	**M**	**Pfizer**	**2**	**Encephalitis, myocarditis**	**MIS**	**21 days**	**Autopsy**
ALUNNI [22]	**2022**	**France**	**1**	**70**	**M**	**AZ**	**1**	**VITT**	**Hematological**	**25 days**	**Autopsy**
TAKAHASHI [23]	**2022**	**Japan**	**1**	**'90s'**	**M**	**Pfizer**	**3**	**Pericarditis**	**Cardiovascular**	**14 days**	**Autopsy**
MURATA [24]	**2022**	**Japan**	**4**	**34 (mean)**	**M**	**Moderna, Pfizer**	**2**	**Cytokine Storm**	**Immunological**	**1-10 days**	**Autopsy**
SATOMI [25]	**2022**	**Japan**	**1**	**61**	**F**	**Pfizer**	**1**	**Myocarditis**	**Cardiovascular**	**10 days**	**Autopsy**

SUZUKI [26]	**2021**	**Japan**	**54**	**68.1 (mean)**	**37% F**	**Pfizer, Moderna**	**1-2**	**Various**	**Various**	**<7 days**	**Autopsy**
MELE [27]	**2022**	**Italy**	**1**	**54**	**M**	**J&J**	**1**	**VITT**	**Hematological**	**~21 days**	**Autopsy**
YOSHIMURA [28]	**2022**	**Japan**	**1**	**88**	**F**	**Moderna**	**2**	**VI-ARDS**	**Respiratory**	**18 days**	**Autopsy**
RONCATI [29]	**2022**	**Italy**	**3**	**72.3 (mean)**	**2 F**	**Pfizer**	**1-2**	**VITT**	**Hematological**	**18-122 days**	**Autopsy**
KANG [30]	**2022**	**Korea**	**1**	**48**	**F**	**AZ, Pfizer**	**2**	**Myocarditis (required transplant, no death)**	**Cardiovascular**	**15 days**	**Necropsy (heart)**
KAMURA [31]	**2022**	**Japan**	**1**	**57**	**M**	**Moderna**	**1**	**Thrombosis/rhabdomyolysis**	**MIS**	**53 days**	**Autopsy**
ISHIOKA [32]	**2022**	**Japan**	**1**	**67**	**M**	**Pfizer**	**1**	**Exacerbation of UIP**	**Respiratory**	**3 days**	**Autopsy**
GILL [33]	**2022**	**USA**	**2**	**‘teenage’**	**M**	**Pfizer**	**2**	**Myocarditis**	**Cardiovascular**	**3-4 days**	**Autopsy**
POMARA [34]	**2022**	**Italy**	**1**	**37**	**F**	**AZ**	**1**	**VITT**	**Hematological**	**24 days**	**Autopsy**
YEO [35]	**2022**	**Singapore**	**28**	**65.1 (mean)**	**17.9 % F**	**Pfizer, Moderna**	**1-2**	**Various**	**Various**	**<3 days**	**Autopsy**
AMERATUNGA [36]	**2022**	**New Zealand**	**1**	**57**	**F**	**Pfizer**	**1**	**Myocarditis**	**Cardiovascular**	**3 days**	**Autopsy**

GUNTHER [37]	**2021**	**Germany**	**1**	**54**	**M**	**AZ**	**1**	**VITT**	**Hematological**	**~121 days**	**Autopsy**
PERMEZEL [38]	**2022**	**Australia**	**1**	**63**	**M**	**AZ**	**1**	**ADEM**	**Neurological**	**32 days**	**Autopsy**
CHOI [39]	**2021**	**Korea**	**1**	**22**	**M**	**Pfizer**	**1**	**Myocarditis**	**Cardiovascular**	**5 days**	**Autopsy**
SCHNEIDER [40]	**2021**	**Germany**	**18**	**62.6 (mean)**	**50% F**	**AZ, Pfizer, Moderna, J&J**	**1-2**	**Various**	**Various**	**1-14 days**	**Autopsy**
VERMA [41]	**2021**	**USA**	**1**	**42**	**M**	**Moderna**	**2**	**Myocarditis**	**Cardiovascular**	**~14 days**	**Autopsy**
WIEDMANN [42]	**2021**	**Norway**	**4**	**41.8 (mean)**	**F**	**AZ**	**1**	**VITT**	**Hematological**	**7-25 days**	**Autopsy**
POMARA [43]	**2021**	**Italy**	**2**	**43.5 (mean)**	**1 F**	**AZ**		**VITT**	**Hematological**	**16-24 days**	**Autopsy**
ALTHAUS [44]	**2021**	**Germany**	**2**	**36 (mean)**	**1 F**	**AZ**	**1**	**VITT**	**Hematological**	**16-17 days**	**Autopsy**
EDLER [45]	**2021**	**Germany**	**3**	**‘elderly’**	**1 F**	**Pfizer**	**1**	**COVID-19, MI, PE**	**Cardiovascular, Hematological, Respiratory**	**2-12 days**	**Autopsy**
HANSEN [46]	**2021**	**Germany**	**1**	**86**	**M**	**Pfizer**	**1**	**Renal/respiratory failure**	**MIS**	**26 days**	**Autopsy**

BARONTI [47]	**2022**	**Italy**	**5**	**64 (mean)**	**1 F**	**Pfizer, Moderna**	**1-2**	**MI**	**Cardiovascular**	**<1 day – 21 days**	**Autopsy**
ITTIWUT [48]	**2022**	**Thailand**	**13**	**42.8 (mean)**	**23% F**	**AZ, Sinopharm, Sinovac, Pfizer, Moderna**	**1-3**	**Various**	**Various**	**1-7 days**	**Autopsy**
GREINACHER [49]	**2021**	**Germany**	**1**	**49**	**F**	**AZ**	**1**	**VITT**	**Hematological**	**10 days**	**Autopsy**
MAURIELLO [50]	**2021**	**Italy**	**1**	**48**	**F**	**AZ**	**1**	**VITT**	**Hematological**	**39 days**	**Autopsy**
BJØRNSTAD-TUVENG [51]	**2021**	**Norway**	**1**	**'young'**	**F**	**AZ**	**1**	**VITT**	**Hematological**	**~10 days**	**Autopsy**
SCULLY [52]	**2021**	**U.K.**	**1**	**52**	**F**	**AZ**	**1**	**VITT**	**Hematological**	**~>10 days**	**Autopsy**
CHOI [53]	**2021**	**Korea**	**1**	**38**	**M**	**J&J**	**1**	**SCLS**	**Hematological**	**2 days**	**Autopsy**
SCHWAB [54]	**2023**	**Germany**	**5**	**57.6 (mean)**	**3 F**	**Pfizer, Moderna**	**1-2**	**Myocarditis**	**Cardiovascular**	**<7 days**	**Autopsy**
HIRSCHBUHL [55]	**2022**	**Germany**	**29**	**32-97**	**45% F**	**Pfizer, AZ, Sinovac**	**1-2**	**COVID-19**	**Various**	**~1-307 days**	**Autopsy**
HOSHINO [56]	**2022**	**Japan**	**1**	**27**	**M**	**Moderna**	**1**	**Myocarditis**	**Cardiovascular**	**36 days**	**Autopsy**

COLOMBO [57]	**2023**	**Italy**	**5**	**72 (mean)**	**2 F**	**Pfizer**	**2**	**Various**	**Respiratory, MIS**	**188-298 days**	**Autopsy**
MOSNA [58]	**2022**	**Slovakia**	**1**	**71**	**M**	**Pfizer**	**2**	**GBS**	**Neurological**	**10 days**	**Autopsy**
KAIMORI [59]	**2022**	**Japan**	**1**	**72**	**F**	**Pfizer**	**1**	**TMA**	**Hematological**	**2 days**	**Autopsy**

***Cases = Number of deaths examined post-mortem**
****Dose = Cumulative number of vaccine doses received**
*****Period = Time (in days) from most recent vaccine administration to death**
~ = Inferred Period (Estimated period using all available information, definitive period not given)

Table 1.